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PITFALLS IN AUSCULTATION OF THE HEART*

Skillful auscultation and the proper interpretation of auscultatory findings remain of prime importance in cardiac diagnosis. To date it appears unlikely that any mechanical or laboratory aids will render the stethoscope obsolete. However, auscultatory findings may be misleading and must always be evaluated in the light of the total clinical picture. This discussion of auscultatory pitfalls pertains chiefly to patients with normal hearts and those with congenital or rheumatic heart disease. Misleading signs are less often associated with hypertensive or coronary disease.

HEARING WHAT IS THERE

In order to examine the heart well, it is not necessary to possess any unusual talent or even especially sensitive ears. As in other fields of endeavor, it is simply necessary to take the trouble to make the job easy.

Good equipment is the first requirement for this. The stethoscope should have earpieces which are directed forward at an angle parallel to the auditory canals and which are of sufficient size to seal them completely. The tubing should be as short as is consistent with a comfortable posture for the examiner. It is best to have a chest piece which includes both a diaphragm for the easiest perception of high pitched sounds (such as the aortic diastolic whiff) and a bell, which, when *very lightly* applied to the skin, most efficiently transmits low pitched sounds (the apical diastolic rumble).

Extraneous sounds are reduced to a minimum by insisting on quiet surroundings. The patient should not be chilly and generating distracting muscle noise by shivering. Often it is necessary to ask the patient to stop breathing for a moment in order to eliminate the sounds of respiration for a few cardiac cycles. When one is dealing with the problem of a crying youngster, the insertion of a lollipop or a nipple into the mouth may lead to more important information than the insertion of a cardiac catheter into a vein.

The method of listening is also of importance. A skilled examiner finds it impossible to listen to the entire cardiac cycle at once, but in each location he explores, listens to the first sound, then the second, then listens to systole, and finally to diastole. He is not ashamed that his thumb occasionally wanders to the carotid pulse in order to be certain of correct timing. He really does listen along the left sternal border with the patient leaning forward and in full expiration for a faint murmur of aortic regurgitation and after exercise at the apex with the patient lying on the left side for a sign of mitral stenosis which might otherwise be missed. The exact point of maximal intensity of a murmur is determined by careful exploration whenever this is possible.

With normal hearing, reasonable experience, and such maneuvers for making murmurs easier to hear, auscultation compares very favorably with the sensitivity of the finest phonocardiographic equipment.

HEARING WHAT IS NOT THERE

The failure to detect a very faint murmur is usually of minor consequence. It is a far more serious error to record an abnormal finding which is not there, since this causes needless anxiety. If in doubt concerning the presence or absence of a significant finding, it is best not to listen beyond the point of fatigue, but to defer decision until the patient is re-examined on one or more subsequent occasions.

MISLEADING FINDINGS IN NORMAL HEARTS

The evaluation of the innocent or "functional" murmur is the most frequent pitfall encountered in auscultation of the heart. Unfortunately, these murmurs are difficult to define since their intensity, location, and quality vary widely. In the absence of other evidence of heart disease, faint grade 1 systolic murmurs may be considered innocent, irrespective of their quality and location. An exception to this is the patient with a very thick chest wall in whom it is best to assume that the murmur is somewhat more intense than it sounds. Louder systolic murmurs of grade 2 or occasionally grade 3 intensity (grading from 1 to 5) are often innocent. They are most apt to be so when the point of their maximum intensity is in the pulmonary area, along the left sternal border,

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cal". This circumstance arises when the pul- usually associated with an abnormal apical sys-

or medial to the apical impulse. They are infrequently maximal in the aortic area or precisely over the apical impulse and are not transmitted with any significant intensity up the neck vessels or to the axilla. Innocent murmurs are not likely to extend throughout all of systole or to be high pitched or harsh. They are more likely to vary with changes in position and respiration, but this is by no means always the case. The innocent murmur may be indistinguishable from that produced by a number of rheumatic and congenital cardiac lesions. Therefore, cardiac symptoms and other abnormalities indicating cardiac pathology in the physical findings, x-ray, and electrocardiogram should be investigated before a murmur of more than slight intensity is accepted as innocent. When faced with a murmur of questionable significance in a patient who has no other evidence of cardiac abnormality, it is best to err on the side of under-diagnosing rather than over-diagnosing heart disease. If one is in error and an abnormality is present, it is almost always mild. Innocent murmers may appear or be accentuated during pregnancy or in the presence of other causes of an increased cardiac output such as anemia, thyrotoxicosis, or fever. Under these circumstances interpretation may have to be deferred until such conditions have been corrected.

Crackling or scratchy extra-cardiac sounds synchronous with each heart beat can be produced by compression of a portion of lung adjacent to the heart. These usually sound close to the ear and may be markedly affected by respiration. They are normal findings which may be confused with murmurs or with a pericardial friction rub. The systolic click is another normal finding of uncertain origin but of no importance unless it leads to confusion in timing. A systolic murmur is sometimes heard over a dilated or tortuous subclavian or carotid artery. This may be transmitted to the aortic area and thus be confused with the murmur of aortic stenosis.

In children and young adults, the presence of a venous hum sometimes leads to the erroneous diagnosis of aortic valve disease or a "right sided patent ductus arteriosus". The venous hum is a normal finding. It is a low pitched continuous bruit maximal in the aortic area and at the base of the neck. It is loudest when the patient is sitting, often accentuated by extension of the neck, decreased in the lying position, and obliterated by gentle pressure over the right jugular vein. Within the same age group, particularly in thin chested individuals, a third heart sound is a frequent and normal finding. This is a dull sound which occurs in the early portion of diastole and is hence termed protodiastolic.

MISLEADING FINDINGS IN CONGENITAL HEART DISEASE

Although many congenital cardiac lesions produce loud murmurs, this is not always the case. Under a number of circumstances, murmurs may be absent or of low intensity. This is particularly true when an atrial or ventricular septal defect or patent ductus arteriosus is complicated by the presence of considerable pulmonary hypertension. This can decrease or abolish the shunting of blood into the right side of the heart, and, as a result, the murmur is correspondingly diminished and may be entirely absent.

No Shunt

Among the congenital cardiac defects producing no shunt, two deserve special mention because their murmurs often sound innocent. Coarctation of the aorta usually produces a systolic murmur maximal in the second intercostal space to the left of the sternum which is of grade 1 to 3 intensity. Often the murmur is even better heard in the back between the scapulae and this should make one suspicious of coarctation. Occasionally it extends slightly into diastole. The diagnosis is established by demonstrating a lower systolic blood pressure in the legs than exists in the right arm. Therefore, even in the absence of hypertension in the arms, it is a good rule to measure the blood pressure in the legs in all patients before making a diagnosis of innocent murmur.

Many cases of mild pulmonary stenosis are insufficient to produce cardiac enlargement, a pattern of right ventricular hypertrophy in the electrocardiogram, or significant post-stenotic dilatation of the pulmonary artery in the x-ray of the chest. Such patients may have innocent sounding pulmonary systolic murmurs of low intensity. The second heart sound in the pulmonary area may not be diminished, as is often the case in more severe pulmonary stenosis. The presence of an accentuated first heart sound in the pulmonary area is a clue to the presence of mild pulmonic stenosis. In these instances, cardiac catheterization is the only method of establishing the diagnosis with certainty. This is seldom necessary, however, since under the conditions described above, pulmonary stenosis, if present, is of minor importance.

Left to Right Shunt

Among patients with congenital lesions producing a left to right shunt, there are two situations in which the auscultatory findings can cause confusion. In the past, cases of atrial septal defect in which an apical diastolic rumble was present were frequently considered to have mitral stenosis as well, and a diagnosis of Lutembacher's syndrome considered. This diagnosis was entertained in many patients who proved at autopsy to have only the atrial septal defect and no mitral stenosis. We now appreciate the fact that any condition producing a large left to right shunt often causes a precordial or apical diastolic rumble. The latter finding per se usually does not indicate the presence of an additional mitral lesion.

The second group of patients in whom the auscultatory findings are misleading are those with a large patent ductus arteriosus without a continuous murmur. Hence they are called "atypi-

cal". This circumstance arises when the pulmonary artery pressure is increased to the point that flow through the ductus occurs only during systole. As a result, one hears only a systolic murmur maximal over the second left intercostal space. Occasionally a faint diastolic blow of pulmonary regurgitation is heard along the left sternal border. When this is the case, the diagnosis must usually be made by cardiac catheterization. Therefore, in the patient with increased vascularity of the lungs on x-ray examination, one cannot rule out the possibility of a large patent ductus arteriosus on grounds that the characteristic murmur is not heard. Since ligation or division of the ductus is urgently needed in many such individuals, it is of considerable importance that the correct diagnosis is not overlooked.

There are several vascular abnormalities producing continuous murmurs which may be mistaken for patent ductus arteriosus. These include arteriovenous fistula in the chest wall, the very rare coronary arteriovenous fistula, and pulmonary arteriovenous aneurysm, especially if it is located close to the heart.

Right to Left Shunt

In the differential diagnosis of cyanotic congenital heart disease it is important to discover whether or not the patient has a decreased pulmonary blood flow, which is frequently associated with pulmonary stenosis. Under these circumstances the intensity of the second heart sound over the pulmonary area is usually diminished. It is not rare to encounter patients with all the typical findings of the Tetralogy of Fallot save for a pulmonary second sound which is of normal or even slightly increased intensity. This finding may create the erroneous impression that pulmonary hypertension is present. However, careful auscultation will usually indicate that the "pulmonary" second sound, even though loud, is unusually sharp or "pure" and that it may well be due to the closure of the aortic valve rather than to the sound of both semilunar valves, which normally close somewhat asynchronously. The presence then of a normally intense pulmonary second sound, particularly if "pure", should not be taken as evidence against pulmonary stenosis.

The intensity of the pulmonary systolic murmur is isolated pulmonary stenosis and in the Tetralogy of Fallot is importantly influenced by the viscosity of the blood. A decrease in the loudness of this murmur is therefore not a sign of improvement, but should alert one to the possibility that the patient is losing ground because of increasing polycythemia or impaired ventricular function.

MISLEADING SIGNS IN RHEUMATIC HEART DISEASE

Active Rheumatic Fever

An apical diastolic rumble often appears during a bout of active rheumatic carditis. It is usually associated with an abnormal apical systolic murmur as well. Since mitral stenosis takes months or years to develop, such a diastolic murmur should not be attributed to mitral stenosis when observed during active rheumatic fever in childhood. It is probably the result of dilation of the left ventricle in addition to the increased left ventricular inflow caused by mitral regurgitation. Many such apical rumbles disappear as the active carditis subsides.

Difficulty sometimes arises in differentiating a normal third heart sound from an apical diastolic gallop which signifies left ventricular failure. In actuality the third heart sound and the gallop occur in the same portion of the diastolic phase of the cardiac cycle, and they sound alike. They are distinguished only by the circumstances under which they occur. Thus, such a protodiastolic sound is called a normal third sound in a child or young adult in whom there is no cardiac enlargement or other evidence of left ventricular failure. Since normal third sounds are rare in older adults, the presence of an apical protodiastolic sound in this age group is usually due to left ventricular failure. In acute cor pulmonale, such as that produced by a large pulmonary embolus, a gallop may also be heard. In this case, it is maximal to the left of the sternum over the right ventricle rather than at the apex. The location of the gallop may thus be of diagnostic value. Constrictive pericarditis also produces a protodiastolic third sound which is indistinguishable from a gallop.

Interpretation of auscultatory findings may be difficult when a summation gallop is present. This results when the atrioventricular condition time is prolonged sufficiently so that the atrial sound becomes superimposed on a third sound of the previous cardiac cycle. The resulting sound may be much the loudest of the entire cardiac cycle and consequently is often misinterpreted as the first sound. As a result, systole and diastole are transposed in the examiner's mind and all murmurs therefore mistimed. Timing the sound by means of the carotid pulse and by the method of "inching" the stethoscope from the base of the heart toward the apex will avoid this pitfall. One should be particularly alert to this possibility when the electrocardiogram reveals a prolonged P-R interval. It is in such problems of difficult timing that the phonocardiogram is of particular help.

Mitral Valve Disease

In recent years a reliable clinical appraisal of the nature and severity of rheumatic valvular lesions has become of particular importance in deciding when to recommend surgical relief of mitral stenosis. Patients with mitral stenosis often have a faint diminuendo diastolic murmur along the left sternal border which may be due either to slight pulmonary or aortic regurgitation. As yet, it is not possible to distinguish between these. However, if there are no peripheral signs of aortic regurgitation and no evidence of left ventricular hypertrophy, such an ausculta-

tory finding does not contraindicate operation.

A more difficult problem is the evaluation of the degree of mitral regurgitation when it is present in addition to mitral stenosis. Usually when a systolic murmur of moderate or greater intensity is found to be maximal directly over the apex impulse, and particularly if the murmur is well transmitted to the axilla or lung bases, a significant degree of mitral regurgitation is found at operation. The more important question is whether mitral stenosis or mitral regurgitation is the predominant lesion. This cannot be satisfactorily determined on the basis of the relative loudness of the respective murmurs. A history of repeated attacks of acute pulmonary edema favors predominant mitral stenosis; so does the finding of a sharp or loud first sound at the apex, an opening snap of the mitral valve, and a right ventricular hypertrophy pattern in the electrocardiogram. Predominent mitral regurgitation is favored by the finding of a left ventricular hypertrophy pattern in the electrocardiogram. There are some instances in which it is not possible to tell which lesion predominates unless an exploratory operation is done.

Patients have been seen in whom the auscultatory and other clinical findings are typical of pure mitral stenosis; yet at operation pure mitral regurgitation was found. This is a deep pitfall, but fortunately is a very rare one. No reliable method of avoiding it has yet been found. The converse is seen more often. Patients considered to have the murmurs of both mitral stenosis and regurgitation are sometimes found at operation to have pure stenosis with no detectable regurgitation. The frequency with which this error is made will be decreased by more careful attention to the precise location of the point of maximal intensity of systolic murmurs. If one determines by palpation the actual position of the apex impulse and finds that the systolic murmur is loudest some distance medial to this point, or particularly if it is loudest along the left sternal border, the murmur is apt to be due to tricuspid rather than to mitral regurgitation. This is true even in the absence of confirmatory signs of tricuspid regurgitation in the form of a sustained systolic jugular pulse or a pulsating liver. Two other peculiarities of the murmur of tricuspid regurgitation are sometimes present: extreme variability of the intensity with changes in position and accentuation of the murmur during deep inspiration. Loud murmurs of tricuspid regurgitation are often transmitted to the cardiac apex and thus misinterpreted as signifying mitral regurgitation.

In the past few years another group of patients with misleading auscultatory findings has been defined. These people are incapacitated by a high degree of mitral stenosis, yet no apical diastolic murmur can be heard. In some of them a very faint apical diastolic or presystolic murmur is present some times and absent at others. They usually masquerade as chronic pulmonary disease with cor pulmonale, but may be seen with diagnoses ranging from carcinoma of the lung to anxiety neurosis. The true diagnosis may be overlooked unless one is aware that the absence of the murmur does not exclude the possibility of severe mitral stenosis. In these individuals it must be suspected on the basis of hints such as the finding of a sharp first sound at the apex or an opening snap along the left sternal border. Atrial fibrillation or notched P-waves in the electrocardiogram may first arouse suspicion. All of these patients are found to have some enlargement of the left atrium if careful x-ray studies are done. If such clues are found in a chronically dyspneic patient, cardiac catheter study is indicated in order to obtain further evidence of mitral stenosis.

Aortic Valve Disease

Occasionally patients are seen in whom there has been difficulty in distinguishing the murmurs of aortic stenosis and regurgitation from the murmur of a patent ductus arteriosus. Here it is useful to recall that the systolic murmur of aortic stenosis is usually maximal over the aortic area, while the systolic component of the ductus murmer is maximal over the pulmonic area. Furthermore, the murmur of aortic stenosis is "diamond shaped" and hence decreases in intensity prior to the second sound while the ductus murmur continues with undiminished intensity through the second sound.

A high degree of aortic stenosis may be present in an individual in whom an aortic systolic murmur is minimal or absent. Hints are obtained from a history of syncope or angina, a decrease in the intensity of the aortic second sound, the finding of marked left ventricular hypertrophy in the electrocardiogram, calcification of the aortic valve on fluoroscopy, or an anacrotic notch in the arterial pulse tracing. A narrow pulse pressure need not be present. Since the surgical treatment of aortic stenosis is in a developmental and less satisfactory stage, the detection of this lesion is currently of lesser importance than in the case of mitral stenosis.

SUMMARY

Skillful auscultation of the heart requires good equipment, the elimination of distracting extraneous noise, and proper listening technique. Normal findings such as the innocent murmur, extracardiac sound, and the venous hum constitute the most frequently encountered auscultatory pitfalls in cardiac diagnosis. A constant awareness of the characteristics of such normal findings is essential if the error of overdiagnosing heart disease is to be avoided. On the other hand, there are several serious cardiac abnormalities in which the correct diagnosis may be easily overlooked because of the absence of a murmur.

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The opinions and conclusions expressed herein are those of the author and do not necessarily represent the official views of the Scientific Council of the American Heart Association.

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